(12) UK Patent Application (19) GB (11) 2 347 517 (13) A

(43) Date of A Publication 06.09.2000

(21) Application No 9928116.4

(22) Date of Filing 26.11.1999

(30) Priority Data
(31) 10336359 (32) 26.11.1998 (33) JP

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(51) INT CL7
G03F 7/20

(52) UK CL (Edition R)
G2A ACJ AEAA

(56) Documents Cited
US 5739899 A US 5728495 A US 5663784 A
US 5473410 A

(58) Field of Search
UK CL (Edition R) G2A ACJ AEAA AFX
INT CL7 G03B 27/52 27/68 , G03F 7/20
Online databases: WPI, EPODOC, PAJ

(54) Abstract Title
Improving synchronicity in a scanning projection aligner using a shaped aperture

(57) A scanning projection aligner transfers a pattern image from a reticle (M) mounted on a mask stage (3) to a photo- sensitive layer spread over a semi-conductor wafer (W) mounted on a wafer stage (5) through a relative motion between an image-carrying light beam (R) and the stages, and an aperture plate (9) has a light-transmissive area (9a), which makes a partial coherency between a scanning direction (X3) with the image-carrying light beam and non-scanning direction so as to cancel deformation of a latent image in said photo- sensitive layer due to a difference in synchronization error between the scanning direction and the non-scanning direction. Preferably the light transmissive area is elliptical with its minor axis parallel to the scanning direction.

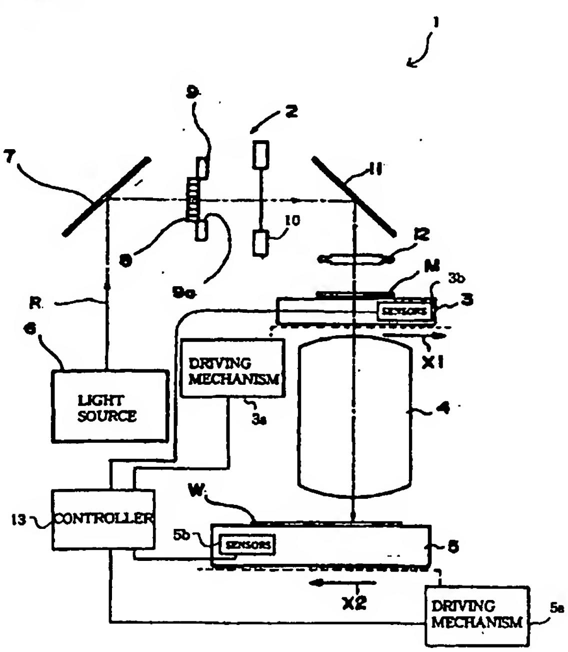

Fig. 4

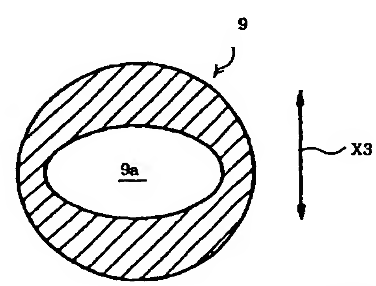

Fig. 5

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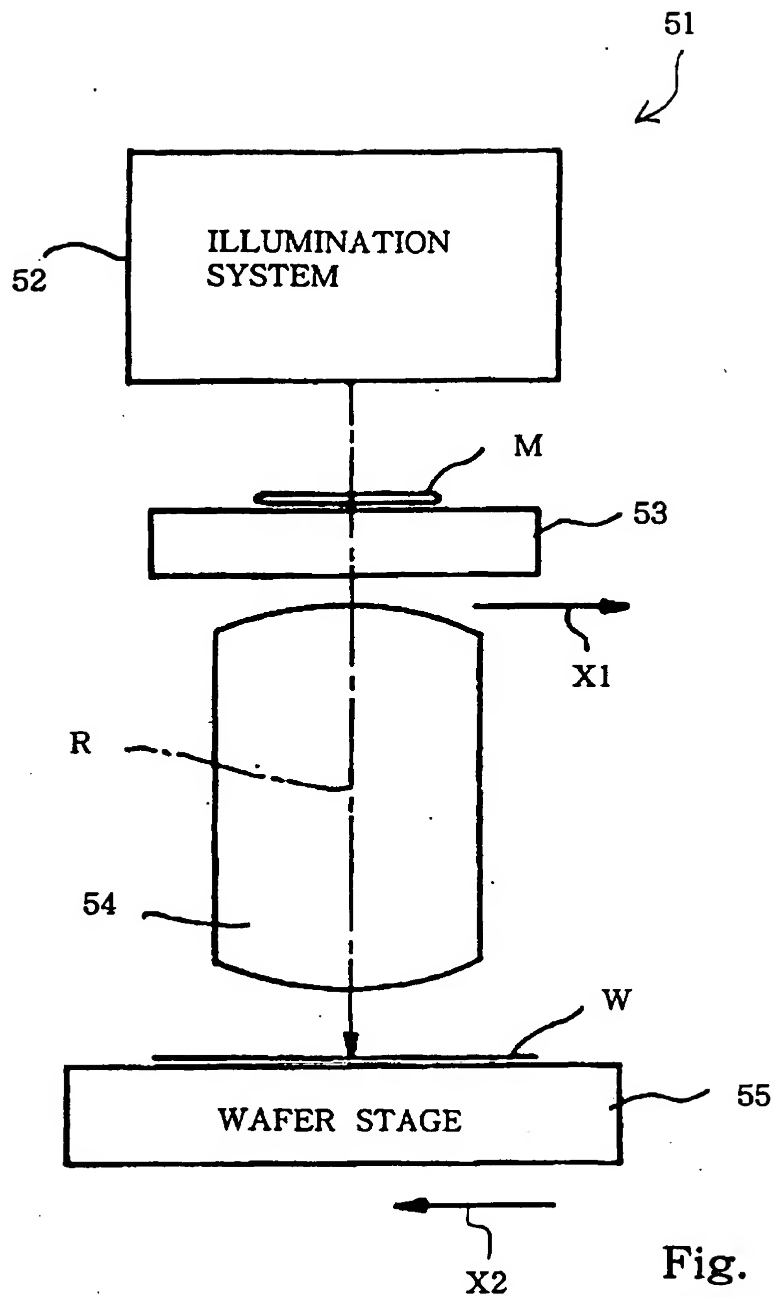

Fig. 1
PRIOR ART

2/5

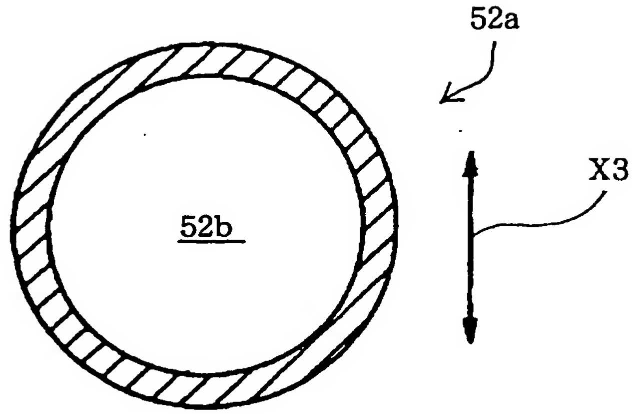

Fig. 2
PRIOR ART

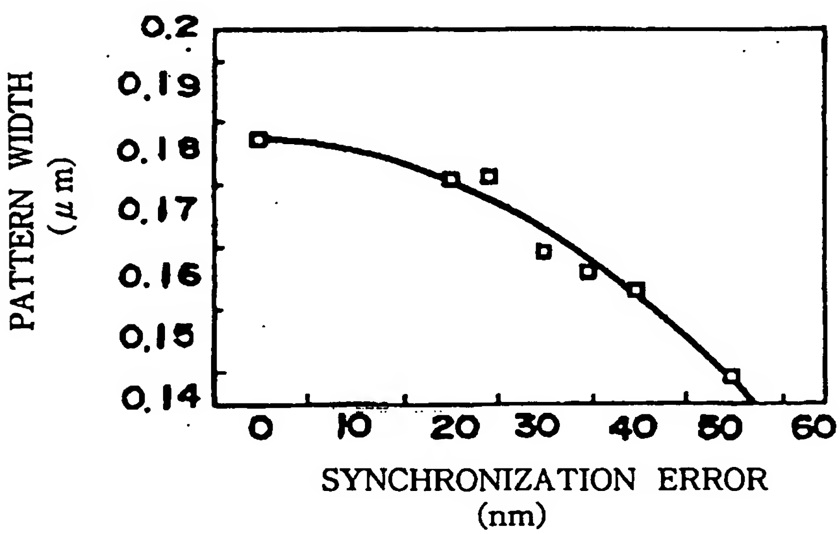

Fig. 3
PRIOR ART

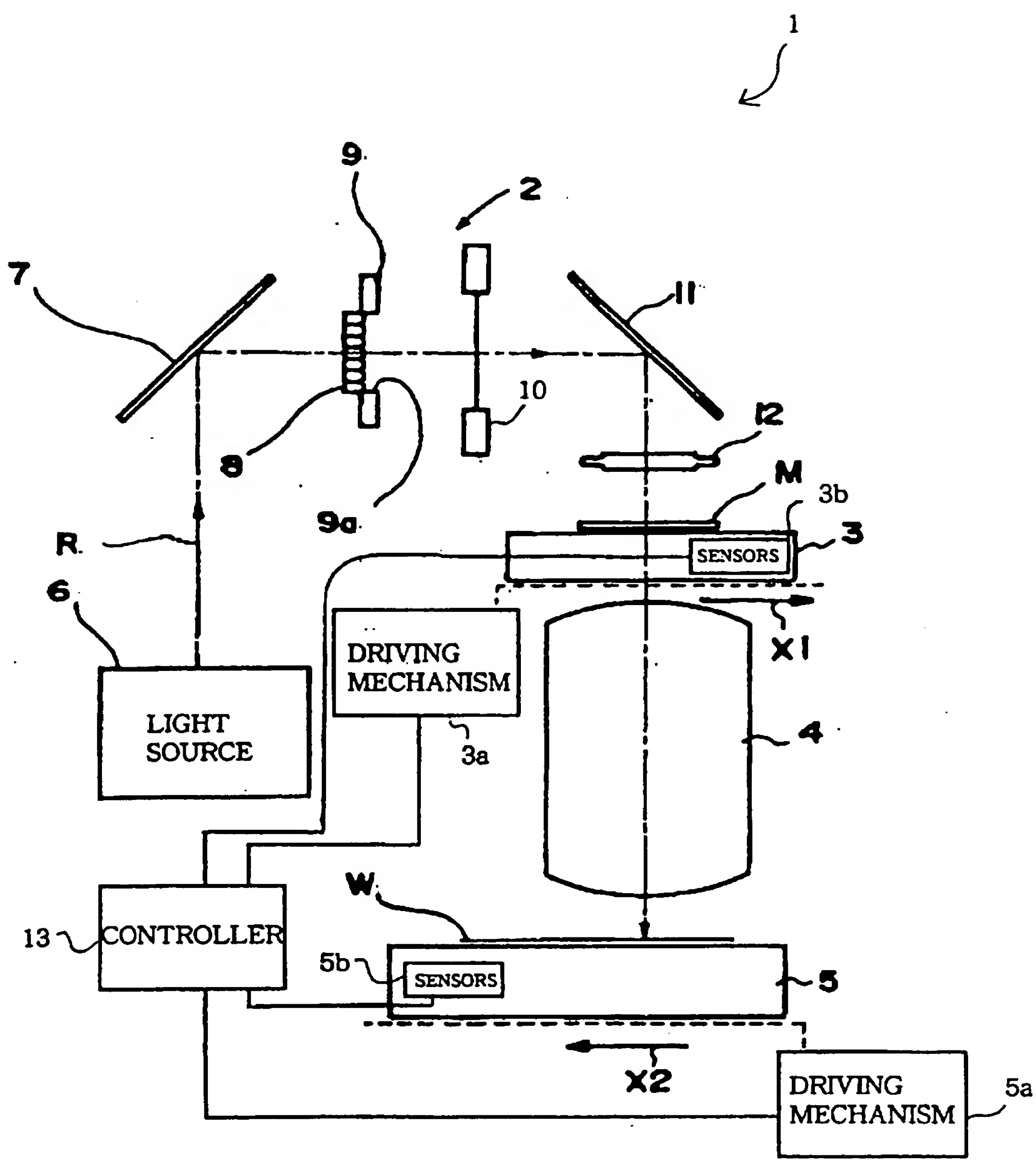
1
2
9
7
11
10
8
9a
12
M
3b
R
SENSORS
3
6
X1
DRIVING
MECHANISM
LIGHT
SOURCE
3a
4
W
13
CONTROLLER
5b
SENSORS
5
X2
DRIVING
MECHANISM
5a

Fig. 4

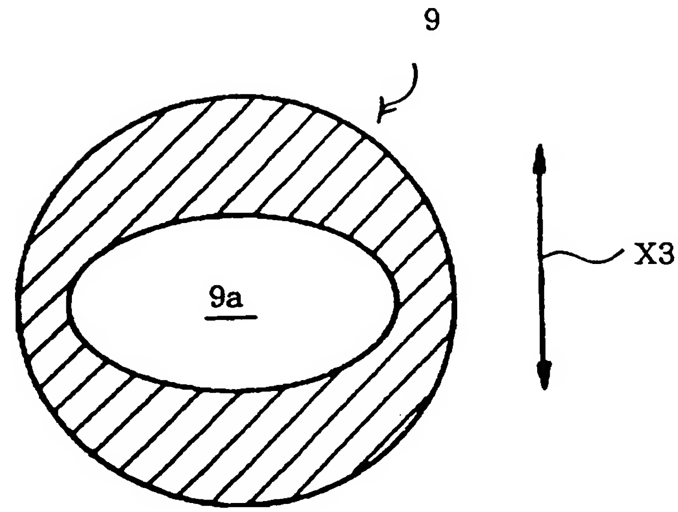
9
9a
X3

Fig. 5

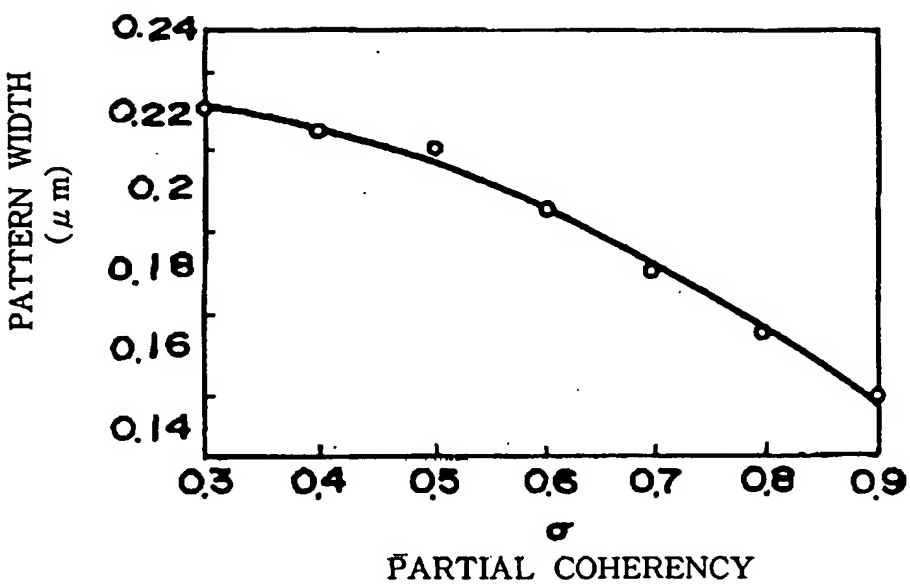
PATTERN WIDTH
(μ m)
0.24
0.22
0.2
0.18
0.16
0.14
0.3
0.4
0.5
0.6
0.7
0.8
0.9
σ
PARTIAL COHERENCY

Fig. 6

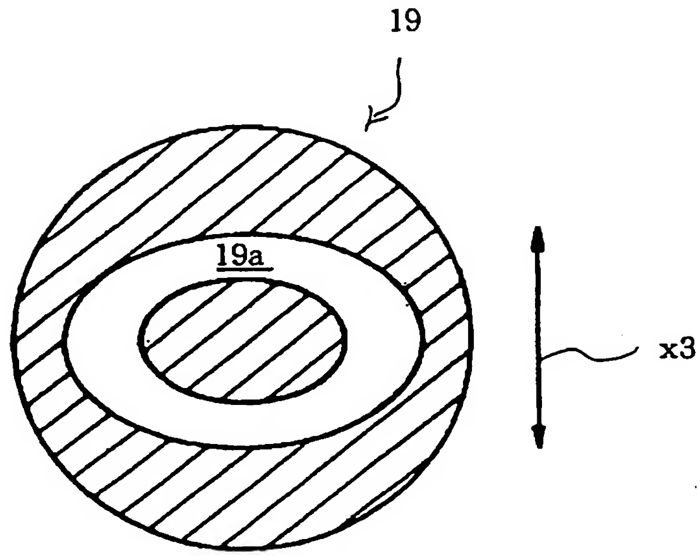

Fig. 7

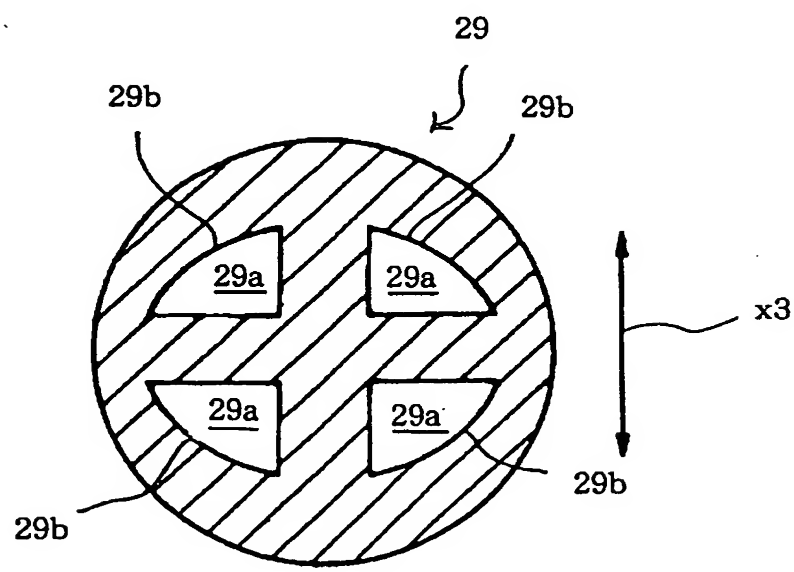

Fig. 8

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SCANNING PROJECTION ALIGNER

FIELD OF THE INVENTION

This invention relates to a scanning projection aligner and, more particularly, to a scanning projection aligner for transferring a pattern image from a photo mask to a photo- sensitive layer on a semiconductor wafer.

DESCRIPTION OF THE RELATED ART

The pattern transfer is a key technology in the semiconductor device manufacturing field. The integration density has been increased, and, accordingly, the circuit components have been miniaturized. The pattern images to be transferred are extremely narrow and thin. The scanning projection aligner is popular to the pattern transfer for the extremely narrow pattern images and the extremely thin pattern images.

Figure 1 illustrates a typical example of the scanning projection aligner. Reference numeral 51 designates the prior art scanning projection aligner. The prior art scanning projection aligner is broken down into an illumination system 52, a reticle stage 53, a projection optical system 54 and a wafer stage 55. The illumination system 52 includes a light source, mirrors (not shown), an aperture plate 52a (see figure 2) and lens units (not shown). The light source generates a light beam, and the mirrors, the aperture plate 52a and lens units guide and shapes the light beam. The aperture plate 52a has a circular light-transmissive area 52b, and the light beam R is stopped down and shared

into a complete round cross section. In order to make the circular light-transmissive area 52b distinguishable from the plate, the plate around the circular light- transmissive area 52b is indicated by hatching lines. The illumination system 52 irradiates a reticle M on the reticle stage 53 with the light beam R.

The reticle stage 53 is located under the illumination system 52, and the reticle M is mounted on the reticle stage 53. A pattern image is formed in the reticle M. Though not shown in figure 1, a driving mechanism is connected to the reticle stage 53, and moves the reticle stage 53 and, accordingly, the reticle M in a direction indicated by arrow X1. As a result, the pattern image in the reticle M is scanned with the light beam R. The light beam R carries the pattern image. A position sensor (not shown) is provided for the reticle stage 53, and supplies a detecting signal representative of a current position of the reticle stage 53 to a controller (not shown).

The projection optical system 54 is located under the reticle stage 53, and A reduction projection lens unit (not shown) is incorporated in the projection optical system 54. The light beam R carrying the pattern image passes the projection optical system 54, and the pattern image is reduced.

The wafer stage 55 is located under the projection optical system 54, and a semiconductor wafer W is mounted on the wafer stage 55. The semiconductor wafer W is covered with a photo- sensitive layer such as a photo- resist layer, and the photo-sensitive layer is exposed to the light beam R. A driving mechanism (not shown) is connected to the wafer stage 55, and moves the wa-

fer stage 55 and, accordingly, the semiconductor wafer W in a direction indicated by arrow X2. As a result, the photo- sensitive layer is scanned with the light beam R. A position sensor (not shown) is also provided for the wafer stage 55, and supplies a detecting signal representative of a current position of the wafer stage 55 to the controller (not shown). The controller is responsive to the detecting signals, and controls the driving mechanisms so as to synchronize the reticle stage 53 with the wafer stage 55.

The pattern image in the reticle M is transferred to the photo- sensitive layer as follows. The reticle M and the semiconductor wafer W covered with the photo- sensitive layer are respectively mounted on the reticle stage 53 and the wafer stage 55. The reticle stage 53 stays at the leftmost position, and the wafer stage 55 is at the rightmost position. The controller (not shown) instructs the driving mechanisms (not shown) to synchronously move the reticle stage 53 rightwardly and the wafer stage 55 leftwardly. The driving mechanism moves the reticle stage 53 in the direction of arrow X1, and the other driving mechanism moves the wafer stage 55 in the direction of arrow X2. The motion of the reticle stage 53 is synchronous with the motion of the wafer stage 55. The illumination system 52 irradiates the reticle M with the light beam R, and the pattern image is carried on the light beam R. As described hereinbefore, the aperture plate 52a makes the light beam completely round. The reticle stage 53 and the wafer stage 55 are moved in a scanning direction indicated by arrow X3 with respect to the aperture plate 52a. However, the light- transmissive area 52b is complete round, and the scanning di-

tection X3 does not have any influence on the cross section of the light beam R.

The image-carrying light beam R is incident onto the projection optical system 54, and the pattern image is reduced. The photo- sensitive layer is scanned with the image-carrying light beam R, and the pattern image is transferred from the reticle M to the photo- sensitive layer on the semiconductor wafer. As described hereinbefore, the controller controls the driving mechanisms to make the reticle stage 53 and the wafer stage 55 synchronous with each other, and the pattern image is expected to be exactly transferred from the reticle M to the photo- sensitive layer through the synchronous motions. The image-carrying light beam R produces a latent image in the photo- sensitive layer.

The semiconductor manufacturer encounters a problem in the prior art scanning projection aligner in that the latent image is not strictly similar to the pattern image on the reticle. When the pattern image to be transferred is miniaturized, the pattern inconsistency becomes serious.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a scanning projection aligner, which produces a latent image corresponding to a pattern image on a photo mask.

The present inventor contemplated the problem, and noticed that the reticle stage 53 was not strictly synchronous with the wafer stage 55. The present inventor evaluated the influence of the synchronization error on the dif-

ference in dimensions between a pattern image to be transferred and a pattern image actually transferred to a photo- sensitive layer. The present inventor prepared a photo-mask, which had an isolated line pattern of 0.18 micron wide. The numerical aperture NA of the aperture plate 52a was 0.6, and the light source generated a KrF excimer laser light. The aperture plate 52a was installed in the illumination system 52, and the photo mask was mounted on the stage 53. The present inventor intentionally introduced the synchronization error between the stages 53 and 55, and measured the pattern width actually transferred. The relation between the synchronization error and the pattern width was plotted in figure 3. When the synchronization error was increased, the pattern width was deviated from the target pattern width of 0.18 micron wide. If the synchronization error was 40 nanometers in the scanning direction and 20 nanometers in a direction perpendicular to the scanning direction, by way of example, the difference between the pattern widths actually transferred was 0.015 micron. The present inventor concluded that the difference in synchronization error deformed the pattern actually transferred to the photo- sensitive layer.

The present inventor searched a document for a solution. Although each of Japanese Patent Publication of Unexamined Application Nos. 9-167736 and 9-232228 disclosed a scanning exposure systems and a fabrication process using the same, the prior art scanning exposure systems did not offer any solution of the above-described problem.

The present invention proposes to cancel the deviation of an image by appropriately adjusting a partial coherency.

In accordance with one aspect of the present invention, there is provided a scanning projection aligner comprising a light beam generating system generating a light beam and radiating the light beam along an optical path, a first stage retaining a mask formed with a pattern to be transferred in the optical path, moved in a scanning direction with respect to the light beam so as to expose all the pattern to the light beam and producing an image-carrying light beam on which an image of the pattern is carried, a projection optical system provided in the optical path and projecting the image to a photo- sensitive layer, a second stage retaining the photo-sensitive layer in the optical path, moved in the scanning direction with respect to the image-carrying light beam synchronously with the first stage so as to expose the photo- sensitive layer to the image- carrying light beam and producing a latent image of the pattern therein and an aperture plate provided in the optical path and having a light-transmissive area allowing the light beam to pass and shaped in a predetermined configuration for canceling a deviation of a latent image due to a difference in synchronization error of the first and second stages between the scanning direction and a non-scanning direction different from the scanning direction.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic view showing the prior art scanning projection aligner;

Fig. 2 is a plane view showing the aperture plate incorporated in the prior art scanning projection aligner;

Fig. 3 is a graph showing the relation between the synchronization error and the pattern width actually transferred;

Fig. 4 is a schematic view showing a scanning projection aligner according to the present invention;

Fig. 5 is a plane view showing an aperture plate incorporated in the scanning projection aligner;

Fig. 6 is a graph showing a relation between a partial coherency and a pattern width actually transferred;

Fig. 7 is a plane view showing an aperture plate incorporated in another scanning projection aligner according to the present invention; and

Fig. 8 is a plane view showing an aperture plate incorporated in yet another scanning projection aligner according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

Referring to figure 4 of the drawings, a scanning projection aligner embodying the present invention is designated by reference numeral 1. The

scanning projection aligner 1 is used for a pattern transfer in a process for fabricating a semiconductor device, and the pattern transfer is known as "photo- lithography". The scanning projection aligner 1 largely comprises an illumination system 2, a mask stage 3, a projection optical system 4 and a wafer stage 5. Though not shown in the drawings, these components 2, 3, 4 and 5 are supported by a frame. The illumination system 2 irradiates a light beam R to a photo mask or a reticle M on the mask stage 3, and a pattern image in the reticle M is carried on the light beam R. The image-carrying light beam R passes through the projection optical system 4, and the pattern image is reduced. The reduced image-carrying light beam R is fallen onto a photo- sensitive layer spread over a semiconductor wafer W on the wafer stage 5.

The illumination system 2 includes a light source 6, a reflection mirror 7, a fly-eye lens unit 8, an aperture plate 9, a mask blind 10, a reflection mirror 11 and a condenser lens unit 12. The light source 6 generates light, and irradiates the light beam R to the reflection mirror 7. The light beam R is incident on the reflection mirror 7 at 45 degrees, and is directed to the fly-eye lens unit 8. The fly-eye lens unit 8 makes the light beam R uniform.

The aperture plate 9 has a light- transmissive area 9a, and the aperture plate 9 is indicated by hatching lines in figure 5 for discriminating it from the light- transmissive area 9a. The light- transmissive area 9a has an elliptical configuration. In this instance, the minor axis of the elliptical light- transmissive area 9a is aligned with a scanning direction X3, and the major axis of the elliptical light- transmissive area 9a is perpendicular to the scanning direction

X3. The direction parallel to the major axis is referred to as "non-scanning direction", which means that the scanning projection aligner does not scan the photo- sensitive layer with the reduced image-carrying light beam R. The fly-eye lens unit 8 is attached to the aperture plate 9, and closes the light-transmissive area 9a. The aperture plate 9 stops down the light beam R, and the fly-eye lens unit 8 makes the light beam R uniform.

The mask blind 10 determines an area on the reticle M to be illuminated with the light beam R. The light beam R passes the mask blind 10, and is incident on the reflection mirror 11. The light beam R is reflected on the reflection mirror 11 at 45 degrees. The reflection mirror 11 directs the light beam R toward the condenser lens unit 12, and the condenser lens unit 12 concentrates the light beam R on a scanning area on the reticle M. A pattern image is formed in the reticle M, and the reticle M is mounted on the mask stage 3.

The mask stage 3 is connected to a driving mechanism 3a, and is monitored with position sensors 3b. The driving mechanism 3a and the position sensors 3b are connected to a controller 13. The driving mechanism 3a, the position sensors 3b and the controller 13 are parts of the scanning projection aligner according to the present invention. The driving mechanism 3a moves the mask stage 3 in a direction indicated by arrow X1, and the trajectory of the mask stage 3 is in parallel to the scanning direction X3. The position sensors 3b detect a first current position on a trajectory of the mask stage 3 and a second current position of the mask stage 3 in the non-scanning direction.

The position sensors 3b produce detecting signals representative of the first current position and the second current position, and supply the detecting signals to the controller 13. Although the illumination system 2 and, accordingly, the light beam R are stationary with respect to the frame, the mask stage 3 is movable, and a relative motion takes place between the light beam R and the pattern image on the reticle M. As a result, the pattern image on the reticle M is scanned with the light beam R, and is carried on the light beam R. The image-carrying light beam R is incident onto the projection optical system 4.

The projection optical system 4 includes a reduction projection lens unit (not shown), and the pattern image is reduced. The reduced image-carrying light beam R is fallen onto the wafer stage 5.

The semiconductor wafer W is mounted on the wafer stage 5, and is covered with the photo- sensitive layer such as, for example, a photo- resist layer. The wafer stage 5 is connected to a driving mechanism 5a, and is monitored with position sensors 5b. The driving mechanism 5a and the position sensors 5b also form parts of the scanning projection aligner according to the present invention. The driving mechanism 5a is connected to the controller 13, and moves the wafer stage 5 in a direction indicated by arrow X2. The trajectory of the wafer stage 5 is in parallel to the scanning direction X3. The position sensors 5b detect a first current position on a trajectory of the wafer stage 5 and a second current position of the wafer stage 5 in the non-scanning direction. The position sensors 5b produce detecting signals representative of the

first current position and the second current position, and supply the detecting signals to the controller 13. Although the reduced image-carrying light beam R is stationary with respect to the frame, the wafer stage 5 is movable, and a relative motion takes place between the reduced image-carrying light beam R and the photo- sensitive layer o the semiconductor wafer W.

The controller 13 synchronizes the driving mechanisms 3a and 5a with each other so as to transfer the pattern image onto the photo- sensitive layer. The position sensors 3b and 5b vary the detecting signal representative of the first current position of the mask stage 3 and the detecting signal representative of the first current position of the wafer stage 5 during the pattern transfer, and the controller 13 may use the detecting signals for a feedback control.

Using the scanning projection aligner, the pattern image is transferred from the reticle M to the photo- sensitive layer on the semiconductor wafer W as follows. The reticle M and the semiconductor wafer W covered with the photo- sensitive layer are respectively mounted on the mask stage 3 and the wafer stage 5, and the controller 13 instructs the driving mechanisms 3a and 5a to synchronously move the mask stage 3 in the direction indicated by arrow X1 and the wafer stage 5 in the direction indicated by arrow X2. The light source 6 irradiates the light beam 6 through the fly-eye lens unit 8, the aperture plate 9 and the condenser lens unit 12 to the reticle M, and the pattern image on the reticle M is scanned with the light beam 6. Then, the pattern image is carried on the light beam R, and the image-carrying light beam R passes the projection optical system 4. The reduced image-carrying light

beam R is fallen onto the photo-sensitive layer, and the pattern image is transferred to the photo- sensitive layer through the two kinds of relative motion. The reduced image- carrying light beam R produces a latent image of the pattern on the reticle M, and the latent image is developed in developing solution.

The elliptical light- transmissive area makes a partial coherency different between the scanning direction X3 and the non-scanning direction. The partial coherency σ is defined as

$$\sigma = NAi / NAl$$

where NAi is the numerical aperture of the illumination and NAl is the numerical aperture of the lens.

The difference in the partial coherency σ cancels or at least partially compensates the dimensional difference due to the different synchronization error, and the pattern image actually transferred corresponds or is strictly similar to the pattern image to be transferred.

The present inventor investigated a relation between the partial coherency σ and variation of a pattern width. The present inventor prepared aperture plates, which made the partial coherency different from 0.3 to 0.9. An isolated line pattern of 0.18 micron wide was transferred to photo- sensitive layers through the aperture plate, and the pattern transfer was repeated by changing the aperture plates. The pattern width actually transferred was measured, and the optimum partial coherency σ was plotted for different pattern widths in figure 6. When the partial coherency was adjusted to 0.7, the line pattern width of 0.18 micron was exactly transferred to the photo- sensitive layer.

Description is hereinbelow made on how the elliptical light-transmissive area 9a is determined. First, the controller 13 instructs the driving mechanisms 3a and 5a to synchronously move the mask stage 3 and the wafer stage 5. The driving mechanisms 3a and 5a move the mask stage 3 along the trajectory in the direction indicated by arrow X1 and the wafer stage 5 along the trajectory in the direction indicated by arrow X2 synchronously with one another. The position sensors 3b periodically check the mask stage 3 for the first current position and the second current position, and vary the detecting signals representative of the first and second current positions of the mask stage 3. The detecting signals are supplied from the position sensors 3b to the controller 13. Similarly, the position sensors 5b periodically check the wafer stage 5 for the first current position and the second current position, and vary the detecting signals representative of the first and second current positions of the wafer stage 5. The detecting signals are supplied from the position sensors 5b to the controller 13. The controller 13 may transfer the detecting signals to an analyzer (not shown). Thus, the variation of current positions is stored in a suitable memory for both stages 3 and 5.

Subsequently, the analyzer calculates the first synchronization error in the scanning direction and the second synchronization error in the non-scanning direction. The relation between the synchronization error and the pattern width (see figure 3) is stored in the analyzer, and the analyzer estimates the amount of deviation of a pattern on the photo- sensitive layer on the basis of the first synchronization error and the second synchronization error.

Subsequently, the analyzer determines a difference in the partial coherency σ between the scanning direction and the non-scanning direction. The difference in the partial coherency σ is adjusted in such a manner as to cancel the amount of deviation of the pattern.

Finally, the analyzer determines a property of an ellipse to be required for the difference in the partial coherency σ. Thus, the configuration of the elliptical light- transmissive area 9a is determined.

As will be understood from the foregoing description, the elliptical light-transmissive area 9a varies the partial coherency σ between the scanning direction and the non-scanning direction, and the appropriately regulated partial coherency cancels the deviation of the pattern due to the difference in synchronization error between the scanning direction and the non-scanning direction. As a result, the scanning projection aligner according to the present invention can transfer a pattern image corresponding to the pattern image on a photo mask onto a photo-sensitive layer.

Second Embodiment

Turning to figure 7 of the drawings, an aperture plate 19 has an elliptical annular light- transmissive area 19a. In order to make the elliptical annular light- transmissive area 19a clearly discriminative, the plate is indicated by hatching lines. The aperture plate 19 is incorporated in another scanning projection aligner embodying the present invention. However, other components are similar to those of the scanning projection aligner 1. For this reason, when the other components are referred to in the following description, they

are labeled with the same references designating corresponding components of the first embodiment.

The scanning projection aligner implementing the second embodiment is equipped with the aperture plate 19 instead of the aperture plate 9. The aperture plate 19 is appropriate for a high resolution in the pattern transfer. The property of the ellipse of the aperture plate 19 is determined as similar to the elliptical configuration of the aperture plate 9. The elliptical annular light-transmissive area 19a makes the partial coherency σ different between the scanning direction X3 and the non-scanning direction, and the difference in the partial coherency σ cancels the deviation due to the difference in the synchronization error between the scanning direction X3 and the non-scanning direction. Thus, the scanning projection aligner implementing the second embodiment achieves the advantages of the first embodiment.

Third Embodiment

Turning to figure 8 of the drawings, an aperture plate 29 has a light-transmissive area 29a separated into four segments. In order to make the elliptical annular light- transmissive area 29a clearly discriminative, the plate is indicated by hatching lines. The aperture plate 29 is incorporated in yet another scanning projection aligner embodying the present invention. However, other components are similar to those of the scanning projection aligner 1. For this reason, when the other components are referred to in the following description, they are labeled with the same references designating corresponding components of the first embodiment.

The scanning projection aligner implementing the third embodiment is equipped with the aperture plate 29 instead of the aperture plate 9. The aperture plate 29 is appropriate for a high resolution in the pattern transfer. The curved peripheries 29b of the four segments are aligned with parts of the periphery of an ellipse. The property of the ellipse for the four segments is determined as similar to the elliptical configuration of the aperture plate 9. The elliptical annular light-transmissive area 29a makes the partial coherency σ different between the scanning direction X3 and the non-scanning direction, and the difference in the partial coherency σ cancels the deviation due to the difference in the synchronization error between the scanning direction X3 and the non-scanning direction. Thus, the scanning projection aligner implementing the third embodiment achieves the advantages of the first embodiment.

Although particular embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the present invention. For example, the aperture plate 9, 19 or 29 is available for another kind of scanning aligner. The location of the components 2, 3, 4 and 5 is not limited to that shown in figure 4.

A standard photo- mask may be used in the pattern transfer. The pattern may be transferred at any demagnification ratio.

The scanning projection aligner may be used in a fabrication process for a charge-coupled device or a magnetic head.

While the present invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation and that changes may be made to the invention without departing from its scope as defined by the appended claims.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

Statements in this specification of the "objects of the invention" relate to preferred embodiments of the invention, but not necessarily to all embodiments of the invention falling within the claims.

Reference numerals appearing in the claims are for illustration purposes only and are not intended to limit the scope of the claims.

The text of the abstract filed herewith is repeated here as part of the specification.

A scanning projection aligner transfers a pattern image from a reticle M mounted on a mask stage 3 to a photo-sensitive layer spread over a semi-conductor wafer W mounted on a wafer stage 5 through a relative motion between an image-carrying light beam R and the stages, and an aperture plate 9 has an elliptical light-transmissive area 9a, which makes a partial coherency between a scanning direction X3 with the image-carrying light beam and non-scanning direction so as to cancel deformation of a latent image in said photo-sensitive layer due to a difference in synchronization error between the scanning direction and the non-scanning direction.

CLAIMS

1. A scanning projection aligner for transmitting a light beam along an optical path to an object comprising:

an aperture plate having a light transmissive area through which said optical path passes;

first scanning means for scanning with the light beam a mask formed with a pattern, the optical path passing through the mask so that the light beam carries an image of the pattern;

means for projecting the light beam on to an object for creating a latent image of the pattern on the object;

second scanning means for scanning the light beam on to the object in a second direction relative to the optical path corresponding to the first direction, the first and second scanning means being adapted to effect the scanning of the mask and the object in a synchronous or near-synchronous manner;

wherein the light-transmissive area is shaped so as to compensate at least partially a deviation of the latent image due to a difference between a synchronization error of the first and second scanning means in the first and second directions and a synchronization error in a non-scanning direction.

2. A scanning projection aligner comprising:

a light beam generating system (6/ 7/ 8/ 10/ 11/ 12) generating a light beam (R), and radiating said light beam along an optical path;

an aperture plate (9; 19; 29) provided in said light path, and having a light- transmissive area through which said light beam passes;

a first stage (3) retaining a mask (M) formed with a pattern to be transferred in said optical path, and moved in a scanning direction (X3) with respect to said light beam so as to expose all said pattern to said light beam, thereby producing an image-carrying light beam on which an image of said pattern is carried;

a projection optical system (4) provided in said optical path, and projecting said image to a photo- sensitive layer; and

a second stage (5) retaining said photo-sensitive layer in said optical path, and moved in said scanning direction (X3) with respect to said image-carrying light beam synchronously with said first stage (3) so as to expose said photo- sensitive layer to said image- carrying light beam, thereby producing a latent image of said pattern therein,

wherein

said light- transmissive area (9a; 19a; 29a) is shaped in a predetermined configuration for canceling a deviation of a latent image due to a difference in synchronization error of said first and second stages between said scanning direction and a non-scanning direction different from said scanning direction.

3. The projection scanning aligner as set forth in claim2 , in which said predetermined configuration makes a partial coherency (σ) different between said scanning direction (X3) and said non-scanning direction.

4. The projection scanning aligner as set forth in claim 3, in which said mask is a reticle (M).

5. The projection scanning aligner as set forth in claim 3, in which said light beam generating system has a first lens (8) attached to said aperture plate (9; 19; 29) and a second lens (12) provided in said optical path between said first aperture plate and said first stage so that said light beam successively passes said first lens, said light- transmissive area shaped into said predetermined configuration and said second lens.

6. The projection scanning aligner as set forth in claim 1, in which said predetermined configuration (9a) is an ellipse, and said ellipse is adjusted in such a manner as to make a partial coherency (σ) different between said scanning direction (X3) and said non-scanning direction.

7. The projection scanning aligner as set forth in claim 6, in which said light beam generating system has a first lens (8) attached to said aperture plate (9) and a second lens (12) provided in said optical path between said first aperture plate (9) and said first stage (3) so that said light beam successively

passes said first lens, said light- transmissive area shaped into said ellipse and said second lens.

8. The projection scanning aligner as set forth in claim 5 or claim 7, in which said first lens and said second lens are a fly-eye lens (8) and a condenser lens (12), respectively.

9. The projection scanning aligner as set forth in claim 1, in which said predetermined configuration is an elliptical annulus (19a), and said elliptical annulus is adjusted in such a manner as to make a partial coherency (σ) different between said scanning direction (X3) and said non-scanning direction.

10. The projection scanning aligner as set forth in claim 9, in which said light beam generating system has a first lens (8) attached to said aperture plate (19) and a second lens (12) provided in said optical path between said first aperture plate (19) and said first stage (3) so that said light beam successively passes said first lens, said light- transmissive area shaped into said elliptical annulus and said second lens.

11. The projection scanning aligner as set forth in claim 10, in which said first lens and said second lens are a fly-eye lens (8) and a condenser lens (12), respectively.

12. The projection scanning aligner as set forth in claim 1, in which said predetermined configuration is implemented by four segments (29a) forming four portions of an ellipse, and said ellipse is adjusted in such a manner as to make a partial coherency (σ) different between said scanning direction (X3) and said non-scanning direction.

13. The projection scanning aligner as set forth in claim 12, in which said light beam generating system has a first lens (8) attached to said aperture plate (29) and a second lens (12) provided in said optical path between said first aperture plate (29) and said first stage (3) so that said light beam successively passes said first lens, said light- transmissive area implemented by said four segments and said second lens.

14. The projection scanning aligner as set forth in claim 13, in which said first lens and said second lens are a fly-eye lens (8) and a condenser lens (12), respectively.

15. The projection scanning aligner as set forth in claim 1, in which said photo- sensitive layer is spread over a semiconductor wafer (W).

16. The projection scanning aligner as set forth in claim 15, in which said latent image in said photo- sensitive layer forms a part of a circuit configuration of an integrated circuit.

17. The projection scanning aligner as set forth in claim 16, in which said integrated circuit is used in an ultra large scale integration device.

18. The projection scanning aligner as set forth in claim 16, in which said integrated circuit is used in a charge-coupled device.

19. A scanning projection aligner substantially as herein described with reference to or as illustrated in Figs 4 and 5, 4 and 7 or 4 and 8 of the accompanying drawings.

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Application No: GB 9928116.4
Claims searched: 1-19

Examiner: Richard Nicholls
Date of search: 30 June 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G2A (AEAA, ACJ, AFX)

Int Cl (Ed.7): G03B 27/52, 27/86 ; G03F 7/20

Other: Online databases: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US 5739899 A	(Nikon) see especially part 17 in figure 1 and column 9 lines 10-54	1 and 2 at least
X	US 5728495 A	(Nikon) see especially part 8 in figure 1 and column 7 lines 3-31	1 and 2 at least
X	US 5663784 A	(Nikon) see especially parts 8a and 8b in figure 1 and column 11 lines 7-37	1 and 2 at least
X	US 5473410 A	(Nikon) see especially part 20 in figures 3,8 and 10	1 and 2 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.